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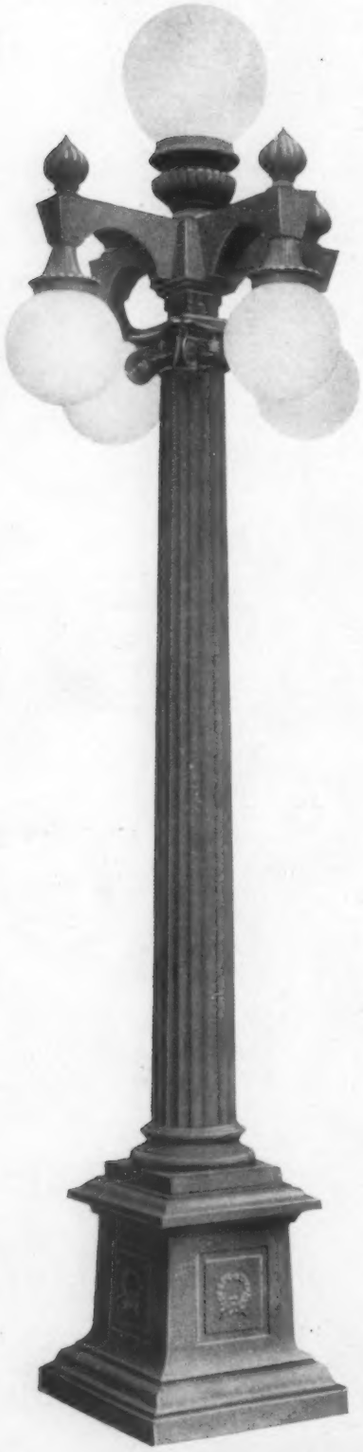

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JOURNAL OF ELECTRICITY
POWER AND GAS
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VOLUME XXIX SAN FRANCISCO, OCTOBER 12, 1912 NUMBER 15

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HYDRO-ELECTRIC POWER PLANTS IN CALIFORNIA[1]

BY J. D. GALLOWAY.

It is now about twenty years ago since the first three-phase plant was commenced near Redlands. It was placed in operation September 7, 1893. The single-phase plant at Oregon City transmitting power to Portland had been operating since 1888 but as three-phase transmission has become standard, the Redlands plant is generally regarded as the starting point of long distance transmission. At Redlands the plant was known as Mill Creek No. 1, the distance to Redlands being 7½ miles and Mentone 4½ miles. There were two 200 kw. generators and the line pressure was 2500 volts. The news of the success of this transmission soon spread and other plants were started. The following list, which merely marks successive advances, is cited for that purpose.

The San Antonia or Original Sierra Plant as it Looks Today.

In July, 1895, the Folsom plant, transmitting power at 11,000 volts to Sacramento, 22½ miles, was placed in operation. In December of the same year, the small plant of the Nevada County Electric Power Company of 1000 horsepower was started. It transmitted power at 5500 volts to Nevada City, 8 miles. It is notable as the beginning of the Pacific Gas & Electric Company. In April, 1896, the San Joaquin Electric Company started delivering power to Fresno, 34½ miles, at 11,000 volts. Impulse wheels were used here under 1411 ft. head. showing a rapid development from the water wheel standpoint. In 1898 the Pioneer Electric Company at Ogden, Utah, commenced operation, transmitting power 36 miles at 11,000 volts. The first plant at Niagara was started that year, transmitting power to Buffalo, 26 miles, at 11,000 volts. In February, 1898, the Telluride Power Company, at Provo, Utah, transmitted power 35 miles at 40,000 volts.

Early in 1899 the Southern California Power Company placed in operation a line 86 miles long at 33,000 volts pressure. In June, 1901, the Bay Counties Power Company first operated the line from Colgate to Oakland, 141 miles, at 40,000 volts. The Great Western Power Company commenced operating at 100,000 volts in 1908 and the Sierra & San Francisco Power Company at a similar voltage in 1910. The limit of increase in voltage and distance is not yet reached.

The size of generators used shows a similar evolution. At Redlands the generators were of 200 kw. capacity. At Folsom, 1905, 750 kw.; at Ogden, 1896, 750 kw.; at Snoqualmie Falls, 1899, 1500 kw.; at Colgate, 1901, 2000 kw.; at de Sabla, 1904, 5000 kw.; and at Las Plumas, 1908, 10,000 kw. P. T. Hanscom proposed a 25,000 kw. unit at Las Plumas this year and the generator and turbine builders gave bids to build it, but the timid easterners were afraid and so someone else must take that step.

My connection with the hydroelectric development commenced that day in May, 1900, when Eugene de Sabla asked if it were possible to suspend a steel cable across the Straits of Carquinez. Designs for the crossing had been prepared by Mr. Koetitz, of the Pacific Construction Company, and the crossing was built. I may not have been as certain of success then as I am now, but the crossing was successful from the start. The really doubtful point was to insulate the cables and this was accomplished by Mr. Sterling. At the towers, the cables rest upon a wooden saddle which in turn rests upon six pin insulators. The first ones installed have been replaced but they stood up under 40,000 volts. The strain insulators, which are placed where the cable is fastened to the anchorages, gave the most trouble. Porcelain was tried but broke under the pressure and then Mr. Stirling devised a combination mica and oil insulator which proved successful. I may be pardoned for referring to this old work, but it has stood the test

[1]Read before the San Francisco Section of the A. I. E. E., Sept. 27, 1912.

Reservoir Site and Dam at Relief Valley During Construction.

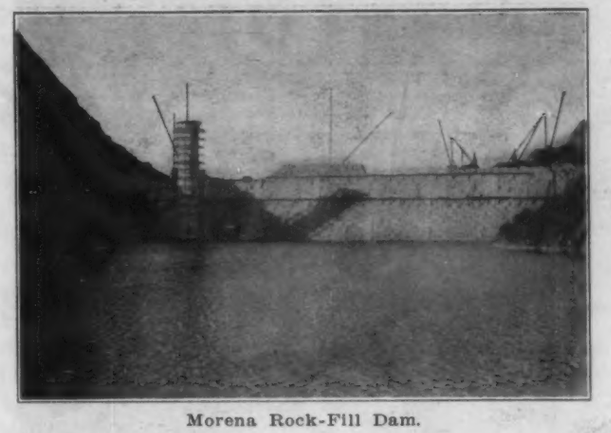
of time and we thought we were doing big things in those days. For length of span this has never been exceeded. There was some question as to whether the wires would swing together in a wind, but this has never occurred to my knowledge.

One feature of mountain plants is the storage reservoir. The necessity for this was recognized at an early date but as it is a costly item it has not always been installed. Probably the most comprehensive system of storage reservoirs was built on the Standard Electric Company's system at Electra. To the miners of early days, we owe the creation of the rock fill dam. Wm. R. Eckart, beside rebuilding the old Blue Lakes dam, constructed the dams at Meadow Lake and Bear Valley. They are of the rock fill type and each about 75 ft. high. The front and rear faces are of derrick laid rock on about ¾ to one slope. They were faced with three layers of plank calked. The leakage a number of years ago, was about three hundred miners' inches, which was negligible. I made plans for two dams of this type on Bishop Creek for the Nevada-California Power Company, but did not superintend the construction. The power company omitted the derrick laid rock on the first dam, merely throwing in loose rock. Considerable settlement took place and the inner skin of planking was distorted, allowing a large leakage. In the dam at Relief Valley on the Sierra and San Francisco Power Company now about 140 ft. high, the laid rock wall is over 100 ft. thick at the bottom, backed with a loose rock fill. This dam is faced with a reinforced concrete skin three feet thick at the top. I joined with Professor C. D. Marx in advising a layer of steel plates in the concrete, but Messrs. Meredith and Frye thought the concrete would do. In this they were in accordance with Sanderson & Porter, the constructing engineers, and time has proved the reinforced concrete a good material. A good example of rock fill dams is the Morena dam recently completed by M. M. O'Shaugnessy near San Diego.

At the present time there are two large dams being constructed, that of the Great Western Power Company at Big Meadows and that of the Pacific Gas & Electric Company at Lake Spaulding. The former is to be of concrete arches of short span resting on buttresses placed in series across the river. This dam will create one of the largest reservoirs in the world, the ultimate storage being over fifty billion cubic feet of water. The Lake Spaulding dam will be of rubble masonry, over three hundred feet high and will impound, if I am correctly informed, some four billion cubic feet of water.

Diverting Dams.

The other dams with which the engineer has to deal in this work is the diverting dam at the head of the flume. That at Electra is a low concrete structure. At Colgate the original dam of the Browns Valley Irrigation District was a log crib filled with rock. When the power company took over that property and built the new flume this dam was raised. In a flood it went out on February 22, 1904. Some quick work was necessary to get a new masonry dam in that summer. It is about 45 ft. high and some 200 ft. long. F. G. Baum hit upon the idea of pumping water from the river into the flume. The pumps, of which there were five, the largest 24 in., lifted the water



Morena Rock-Fill Dam.

some 15 ft. and at the power house it dropped seven hundred, thus giving about one-third the normal plant capacity through the summer. One of those pleasant experiences came when we were building that dam. In no previous September in the records had it ever rained a total of one inch, but about the middle of the month came a rain of seven inches and that gentle stream raised 14 ft. in twenty-four hours. Flumes, trestles, derricks went down stream. One boiler was found at Smartsville, some twenty miles below. We finished the dam, however, early in November.

The dam of the Great Western Power Company at Big Bend is also a concrete masonry structure, 330 ft. long on the crest and about 60 ft. high. During this last summer, in order to obtain greater pondage ten foot flashboards were placed on top of this dam. These were made of timber frames placed every eight feet across the dam and covered with vertical wooden needles. In the recent rise of the river these flashboards had 2½ ft. of water over the top without injury.

The dam of the Sierra and San Francisco Power Company at Sand Bar Flat on the Stanislaus is a timber crib, filled with rock and faced front and back with boards. It is about thirty feet high. The water enters a masonry chamber through openings protected by screens and gates placed nearly parallel with the stream. At de Sabla the dam on Butte Creek is a small timber crib.

Flumes and Ditches.

In many of the existing plants the location of the entire plant was determined by some old ditch built by miners. Such for instance is that of the Tuolumne Water, Light & Power Company, the Standard Electric Company, where the Amador ditch was used; the Utica plant; the Great Western Power Company, where an abandoned mining tunnel was used; the Oro Water, Light & Power Company, where the old Miocene ditch was adapted and de Sabla, where the Cherokee ditch was taken. At Colgate an Irrigation District flume was the determining feature which located the plant. Kern River No. 1 and Stanislaus were the only large plants not so influenced.

The ditches encounter a number of different soils. The red volcanic earth found in a large number of cases becomes practically water tight. Much leakage occurs in lava rock and in the shale such as

Borel Canal, Concrete Lined.

occurs at Electra. In the southern part of the state where water is less abundant, ditches have been lined with concrete. A good example is the second plant of the Mt. Whitney Company on the Kaweah. Grades ordinarily average from 6 ft. to 8 ft. per mile but in red earth greater slopes can be used. One short part of the de Sabla Toadtown ditch has over 20 ft. to the mile slope without erosion.

The wooden flume reached a finished development in California before the power plant era. Some notable flumes are those at Colgate, 6 ft. high and 7 ft. wide and 8 miles long; at Stanislaus 9 ft. wide, 6 ft. high and about 14.8 miles long and at Fleisch on the Truckee River, 10 ft. wide, 6 ft. high and 8900 ft. long. The longitudinal boards are usually 1½ in. thick and as wide as the timber can be sawed. They are usually surfaced on one side. The longitudinal cracks are closed by ⅝ in. x 4 in. battens or as at Fleisch, the planks are grooved and a tongue inserted. The planks are bound by the belting courses placed

Wooden Flume in Stanislaus Canyon.

every four feet. These in turn, rest upon stringers supported on framed bents placed every 16 ft. Grades of 10 ft. to the mile are common, such being used at Colgate and Stanislaus. The velocity of water is very swift at this grade, about 10 ft. per second and if the bottom is out of grade standing waves will originate. A well graded flume should have no trouble from this cause. I have seen water go down a timber flume 300 ft. to a mile grade with little disturbance.

The flume is a temporary expedient and as timber grows more costly, will disappear. It must be admitted that many bold pieces of construction have ben carried out in this work and that the wooden flume has served an important purpose in the development of power plants.

Regulating Reservoirs.

At the end of conduit there should be a regulating reservoir but in many cases there is not. In the earlier plants the importance of the load factor was not recognized. At Electra the upper ditch has only a small reservoir—not nearly large enough and surplus water is spilled down to Tabeaud 200 ft. below At Colgate there is no reservoir. An idea was advanced to install pumps which at low load would be operated to pump surplus water up to Lake Frances, some 400 ft. up hill. No power was obtained by the water returning through this height as it ran in an open pipe. This scheme was not practicable and was not used. At de Sabla, Lime Saddle, and Stanislaus there are reservoirs of ample size to take the daily load variations and also provide a small reserve in case of accident to the conduit. At Big Bend the flash boards mentioned above were built to serve more pondage. At Bishop Creek the first dam at plant No. 4 has been replaced by one giving greater pondage and a fair sized reservoir at Plant No. 2 gives regulation. In some cases, where a number of plants are operated in parallel, the governing and the load changes are taken care of at that particular plant, which has a regulating reservoir.

Pipes.

Riveted steel pipes were highly developed in California by the gold miners. The Cherokee siphon built about 1869 has a head of about 910 ft. The pipe of the Virginia City water works has a head of 1720 ft. across the Washoe Valley with a length of over seven miles. It is 12 in. inside diameter and was built in 1872-3 by Hermann Schussler.

There was thus precedent for the high heads when the power plants were commenced. The following table gives a list of some power plants with data as to conduits, head, and other matters:

Plant.	Length of Conduit.		Head in Ft.	Ratio.
de Sabla	12.5 miles	66,000 ft.	1,530	2.32%
Colgate	8 miles	42,300 ft.	698	1.65%
Electra	19.5 miles	103,000 ft.	1,466	1.42%
Big Bend	2.9 miles	15,168 ft.	450	2.97%
Stanislaus	15.2 miles	80,100 ft.	1,500	1.87%
Centerville ...	8 miles	12,000 ft.	577	1.38%
Bishop No. 4..	3.3 miles	12,200 ft.	1,100	9.05%

At de Sabla, the upper part of the two pipes is riveted plates and the power part 30 in. outside diameter lap welded and flanged. At Colgate the upper part of the pipes is riveted and the lower part cast iron. At Big Bend the first four pipes, 5 ft. diameter, are lap welded. There are now being installed two additional pipes 6 ft. diameter of riveted plates. At Electra the upper section is wood stave where the pressure is light. In the first two pipes next follows some cast iron sections and then lap welded pipe. The third pipe is of riveted plates. At Stanislaus the upper sections are six foot wood stave and lower sections 48 in. and 38 in. riveted pipe. At Bishop Plant No. 4 there are 2.3 miles of wood stave pipe. The first pipe is 30 in. lap welded pipe and the second pipe riveted plates. At Kern River No. 1 the penstock was a pressure tunnel with a lining of thin steel plate. In some way a leak occurred in the lining and water entered the strata of the hill under pressure. Then when the pipe was emptied, the outside pressure collapsed the lining and it was necessary to install, at considerable loss of efficiency, time and money, a pressure pipe inside of the tunnel.

Here I will advance a statement that will certainly cause discussion. I am a firm believer in the superiority of well designed riveted pipe. I have never known one to fail. In the case of lap welded pipe I do not know from personal experience of one, either foreign or of domestic make which has not been patched and banded, or which has burst, with disastrous effects, under high heads. Testimony from other engineers is to the same effect, although there are numbers of lap welded pipes in the world giving satisfaction. I am aware of the difference in friction losses and also of the lesser cost. At Stanislaus five years ago the lap welded pipe was 10 per cent cheaper but was not used. However, if one could see how welded pipe can break with the resulting destruction at the power house there would be little left of an argument.

One thing, sometimes forgotten, is the use of air valves or stand pipes. Calculations of pipe stiffness may also show them able to withstand air pressure when the water column is broken but there are a number of reasons why the pipe will not hold. At Bishop we were laying a 48 in. wood stave pipe near the hydraulic grade line. It was practically level. To keep portions of the pipe wet after completion, dams were built in the pipe about every 500 ft. and the pipe filled with water. One night the lowest dam broke and the water ran out. The air pressure crushed down the pipe at the upper end of that section so that it was necessary to rebuild about 100 ft. A number of accidents have happened allowing water to escape from pipes at the lower end and nearly always the pipe at the upper end has collapsed so that opposite sides have come together.

Air valves should be large size, say 6 in. or 8 in. placed on high points or not over 1000 ft. apart, and provided with a gate valve below. At intervals, the gate valve should be closed and the air valve moved from its seat. This will prevent its "freezing" in place. I know of one place where the pipe collapsed and the air valves were found frozen to their seats. At Bishop the bonnet of a gate valve broke under 1100 ft. pressure, the pipe emptied but the air valves worked and the pipe was uninjured.

In designing pipes, I use for the metal, Manufacturers' Standard Specifications Medium Steel of from 60,000 lb. to 65,000 lb. ultimate strength. The allowed stress is taken at 16,000 lb. per sq. in. afterwards reduced by the joint efficiency to about 11,000 lb. to 12,500 per sq. in. Ordinary double riveted joints can be made of 70 per cent efficiency in thin plates and with triple riveted butt strap joints, an efficiency of 80 per cent can be obtained.

For friction losses, a value of C of 100 in the Chezy formula will give a pipe that will carry the full amount of water after years of service. The question of the economical design of pipe is one of considerable interest. Mr. Arthur Adams has deduced mathematically a rule that a particular pipe is most economical "in which the value of the energy annually lost in frictional resistance equals four-tenths (0.4) of the annual cost of the pipe line." This is a good rule but is subject to a proper understanding of the case. Within reasonable limits of pressure drop due to friction the frictional loss in pipe lines during most of the year can be neglected. There is more than enough water as a rule through nine months of the year and if a little more is passed through the pipes, it does not matter.

Again there is a question as to whether to design the pipes for the average demand for water or to make the peak load demand the criterion. If the load factor is low, say 50 per cent or 60 per cent. and if the pipe is designed for average flow, then the high velocities at peak load will result in a pressure drop. There is a point where more water through a pipe results in less power, owing to increase of friction losses. These losses increase in the ratio of some power of the velocity about the square. I know of one pipe line where this has been reached. There are so many variables in this equation that judgment must finally determine the pipe diameter after a study of the conditions.

Gate Valves.

It is necessary to have gate valves in many cases under high pressure. They should always be of cast steel. Cast iron is most unreliable and the name of the best manufacturers is no guarantee. One valve disc broke under 1500 ft. head with corresponding damage. In the metal was found a bolt head which had never melted. It is painful to recall the numerous failures of cast iron gate valves and nothing is more certain than that cast steel well annealed and of medium hardness should be used. On the new units at Big Bend we are installing six foot pivot or butterfly valves under 430 ft. head. Similar valves have been installed at White River in Washington with success. There is some leakage which is taken care of by a drain.

Water Wheels.

California has contributed to the art of hydroelectric development another important invention, the impulse or tangential water wheel. It is a product of the necessities of the gold miners. Among the names associated with the development of this form

of prime mover are those of Pelton, Knight and Doble.

The impulse wheel is a very simple machine. The form of the buckets varied in different makes. That of the Pelton is somewhat rectangular in plan. The Doble bucket is nearly an ellipsoid of revolution and would seem to be a good type as at no point is the water compelled to make a sharp turn. An important gain was made in the efficiency of the wheel when a dividing wedge was formed in the bucket, so placed that it split the jet into two equal parts, the halves being directed to opposite sides of the wheel.

The form of the jet became of importance as soon as the size of wheels began to increase over the small ones first used by the miners. The necessity of preserving the jet true to form until it reached the bucket led to the invention of the needle nozzle. A long pointed needle is introduced into the center of the jet and the curving surface of the needle directs the jet as a solid bar of water against the buckets of the wheel. The needle also acts as a valve by which the amount of water can be regulated.

The need of sudden regulation due to quick changes in load led to the invention of the deflecting nozzle. Its prototype is the hydraulic giant of the miners. A ball and socket joint allows the nozzle to be instantly deflected from the wheel when the load goes off. This deflection is taken care of by the governor. Another device arranged, I think, by Geo. J. Henry, Jr., consists of a deflector operated by the governor. This consists of a movable shield, somewhat in the shape of a bucket which is introduced into the jet and cuts off from the jet more or less water before it reaches the wheel. The nozzle is fixed and regulation is obtained by varying the position of the deflector.

The deflecting nozzle was an excellent device for medium sized wheels. It has been used on wheels up to 5000 kw. capacity as at de Sabla. It is obvious, however, that the packing of the ball and socket joint is difficult so another device, the synchronous by-pass has been brought out. Here the nozzle is fixed in position and the governor operates the needle for regulation but in order to prevent sudden rises of pressure in the pipe line due to sudden drop in load, the governor operates a by-pass valve through which the water is discharged and the flow in the pipe not materially changed. I believe Mr. Doble is installing this device on the new plant of the Los Angeles aqueduct.

The small wheels of the miners had one nozzle. Then as more power was required, two and three nozzles were placed on one wheel. This was about the limit of number of nozzles. The largest single wheel with two nozzles that I know of is at the Lime Saddle plant of the Oro Water, Light & Power Company. Here two Pelton wheels of two nozzles each operate one 1000 kw. generator. The Girard wheel, which is an impulse wheel with nozzles all around the runner has a representative at Alta. This wheel did not prove of the best efficiency under test and no more were used.

Obviously the power of a single jet is limited by the size of the jet which can not be increased indefinitely. The water must strike the bucket and curve backward and outward to its discharge. If the jet is too great in diameter there is interference of the water and decrease in efficiency. Hence the larger size single wheel can only be used where the fall is great. I believe the largest single jet in use is where the single wheel operates the 5000 kw. generator at de Sabla. Under test over 6000 kw. has been obtained from this single jet. The gross head is 1550 ft. and if I remember, the jet is about 6½ in. diameter. A similar generator was installed at Electra.

The situation at Electra gave a chance for a comparative test which was instructive. As those who are familiar with that plant know, there are two ditches 200 ft. apart vertically giving two heads, one of 1460 ft. and one of 1260 ft. In 1903, two 5000 kw. generators were installed and while one generator was equipped with one wheel on the low head, the second generator had a wheel at each end, one for each head. Tests carried out by Mr. Baum indicated a higher efficiency for the two-wheel unit when each wheel carried one-half the load than when one wheel carried the full load. It would seem that with the resulting size of jet, the most efficient size of wheel had been passed.

At Stanislaus, after considerable discussion, it was decided to install two wheels with single nozzles on the 6700 kw. generators and these generators have since been removed to give about 8500 kw. They are the largest impulse wheel driven generators although the most powerful single wheel is at de Sabla. I understand that at the Big Creek plant of the Pacific Light & Power Company, 10,000 kw. generators with two wheels are being installed. Here the head is nearly 1900 ft. and the size of the generators does not indicate a corresponding increase in size of jet over that at de Sabla where the head is 1530.

There are thus limitations which determine the amount of power to be obtained from impulse wheels. They are not adapted for relatively low heads where the generators are large. Fortunately this is just the condition where the reaction wheel or turbine is most applicable. There is a twilight zone between each type where either are available. Increased power by impulse wheels can be obtained by adding more wheels on the same shaft but this method is expensive and not subject to good regulation.

I believe the first turbine on the coast operating electric generators of large size was that at Snoqualmie Falls. It was of 10,000 h.p. capacity under some 270 ft. head. In 1906, a 1500 kw. generator was installed at Bishop Creek plant No. 5 with a turbine under 400 ft. head. The design of the turbine was poor and the runner wore out. It has since been replaced. About 1907 the 5500 kw. turbine at Centerville under 577 ft. head was installed by Mr. Baum and Mr. Wise and this is, I believe, the highest head under which a turbine is operated.

When the Big Bend plant was started in 1908, the 4-10000 kw. generators operated by single runner turbines were the largest units then built. They operate at 400 r.p.m under a gross head of 430 ft. These wheels were designed for a head of 90 ft. higher, but they have delivered 11,000 kw. under present conditions. It may be of interest to mention that bids were recently taken on units with generators of a capacity of 25,000 kw. at unity power factor and a single run-

ner turbine of 36,000 h.p. capacity. Plans of the turbine were prepared with bids and efficiency guarantees, of nearly 90 per cent given. It is not the fault of the engineers of the power company, of the turbine builders or of the generator makers that these units were not built.

The turbine is more efficient than the impulse wheel. On large units an efficiency of 87 per cent to 90 per cent can be obtained in a turbine and it uses all of the head. Efficiencies of impulse wheels of the best type range from 78 per cent to 82 per cent and some head is lost. However, each has its fairly well defined field.

Regulation of the turbine is accomplished by the variation in size of the openings through which the water enters the runner. I believe this method is familiar to all. It brings up the subject of relief valves. At Bishop we had valves operated by pressure only and they were not very successful. At Centerville a pressure operated valve was installed but it did not work satisfactorily and a device was installed to have the valve directly operated by the governor. A dash pot in the train allowed slight speed changes to be made without opening the relief valve while giving free opening in case of sudden changes.

At Big Bend the tunnel is three miles long and the energy in the moving mass of water is very great. As originally built no relief valves were installed, reliance being had to a stand pipe. This was not sufficient as heavy surges in the tunnel took three-quarters of an hour to die out, and relief valves, directly operated by the governor have been installed. Considerable credit is due Arnold Pfau for the design at Centerville and Big Bend. The new units are to have relief valves operated by oil pressure from the operating cylinders of the turbine.

Having now reached the shaft of the generator and the probable limit of your patience, the cautious civil engineer will go no farther.

ELECTRIFICATION OF MELBOURNE RAILWAYS.

For several years the officials of the Victorian State Railways have been considering the substitution of electric traction for steam locomotives on the suburban lines radiating from the city of Melbourne, Australia. The object is mainly to accelerate and improve the service on these lines, which are now becoming badly crowded. In 1911 the passenger traffic from the Flinder Street Station alone averaged 135,000 persons per day.

ELECTRIC CABLES FOR ARGENTINA.

In connection with the electrification of the suburban railway lines in and about the city of Buenos Aires a contract, which is said to be probably the largest ever placed for an electric-cable installation, and certainly the largest for extra high-tension cables, has recently been placed by the Central Argentine Railway (Ltd.) with a London telegraph works. The principal item consists of 66,000 meters (meter = 3.28 ft.) of 0.1 sq. in. paper insulated, lead covered, and armored three-phase cable for a working pressure of 20,000 volts, which is to be laid directly in the ground.

USE OF ELECTRIC POWER FOR IRRIGATION AND OTHER RURAL PURPOSES.

BY GEORGE C. ARROWSMITH.

(Continued)

Rates and Usage.

I regard a mixed rate for small units as follows:

A fixed charge of $12.00 per year per rated horsepower of customer's connected apparatus, to be paid in equal monthly installments, plus the following meter rates for energy used during each month:

First 30 kw.-hrs. per rated kw. of connected apparatus 3 cents per kw.-hr.;

Next 30 kw.hrs., per rated kw. of connected apparatus, 2 cents per kw.-hr.

Next 120 kw.-hrs., per rated kw. of connected apparatus, 1½ cents per kw.-hr.

Next 240 kw.-hrs., per rated kw. of connected apparatus, 1 cent per kw.-hr.;

All over 420 kw. hours, per rated kw. of connected apparatus, ½ cent per kw.-hr., as being fair, which rate for six months of continuous operation of full load equals a rate (including fixed charge) of $42.00 per horsepower season or year, the revenue from this, however, being increased by the amount that a customer might use for pumping water for domestic purposes or using power for general utility during the non-irrigation season. I would, however, strongly advise the fixed charge being regulated or made upon the irrigation maximum demand instead of connected load, or in other words, call the irrigation maximum demand the connected load. This I would do for three reasons:

1. The customer may want a stated supply of water at a given lift which may require power slightly in excess of a standard size motor and which then calls for the installation of the next larger size, causing the customer to pay an excess fixed charge.

2. Granted a customer—as they do—wants all the water he can get for the full load of any size motor that will supply his needs, thus working said motor at full load for 24 hours per day, 30 days in the month, and I do not consider the modern electric motor quite satisfactory to stand up under these conditions, for its otherwise natural life, especially in the hot summer months of Central Washington climate where the thermometer reaches as high as 104 degrees F. in the shade; also, as sometimes is the case, the efficiency of motors at three-fourths load is slightly greater than that at full load.

3. That in competition with gasoline power, especially to irrigate small tracts of land, the fact that the customer has to pay the excess fixed charge (as in the first clause) and especially where power is used intermittently, militates against the using of electric power.

The fact that the customer may want to use his motor for other purposes during the non-irrigation season and might then use the full power of his motor, or even overload the same, or that the lowering of the general power factor of the company's lines would result, would be offset by the diversity factor and far overshadowed by the general advantages resulting from the adoption of making the maximum demand the connected load, and which maximum demand would be obtained by operating the pumps to full capacity, which would remain the same in localities

where total heads remain the same, and in localities where loads vary, owing to the raising of suction water levels, the conditions are such that the maximum demand exists in the first part of the irrigation season; and in the case of a well designed centrifugal pump, the delivery of water should increase as the suction lift decreases, and the power decrease, but not, of course, in the same proportion nor in quite the same efficiency. For instance, take as an example a motor-driven, direct connected centrifugal pump designed to give a maximum efficiency in delivering 400 gallons per minute at a total head of 35 ft., which, due to the rise of tail water, will perform as follows:

Gal. Per Min.	Total Head.	Comb. Efficiency.	H.P. Input.
400	35	57%	6.2
425	26	51%	5.4
450	20	48%	4.5
475	12	40%	3.6

and which class of apparatus in case of rise and fall of the water supply, such as pertain on the Columbia River, enables the irrigator to supply himself with water at the right ratio during the season with a 30 per cent less horsepower demand than the irrigator with a constant total head.

The foregoing, as regards rates, has referred to the small units, and for large units I regard the same rates with a discount on the monthly metered power used as follows:

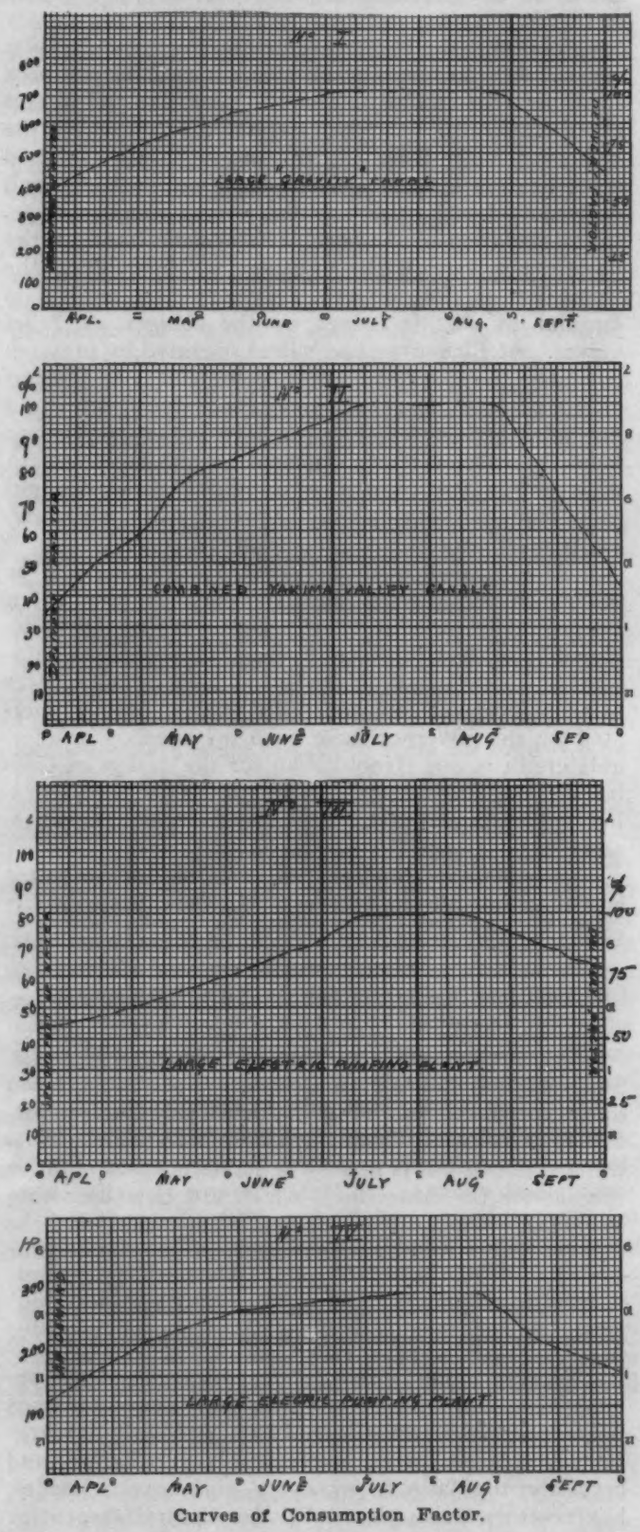
First $100.00 per month, net;
Second $100.00 per month, 15 per cent discount;
Second $200.00 per month, 25 per cent discount;
All over $400.00 per month, 35 per cent discount.

to be an equitable rate that enables large projects to be floated successfully.

I regard these rates quoted as fair to consumers and as low as is compatible with good business for power companies to make, and believe will remain so for some time to come. And as I have often quoted to customers to whom as a general rule, a reduction of 10 or 15 per cent in power rate would only make a difference of, say 50 cents per acre year, and granted that their land was in bearing, if 50 cents per acre year spelled the difference between success and failure, they had better not irrigate. And, as before in this treatise stated, of what use to cry lower rates and get a reduction of a few per cent in rate, especially when said reduction may mean teh margin of safety for a power company having a large power load of this description, when today, generally speaking, the average reduction that a customer—by reason of better apparatus and methods—can make in power used for the same or better results is about 25 or 50 per cent. And again, I claim that for their own protection, as well as for the lasting benefit of their customers, it is up to the power companies, one way or another, to see that this is done first, before any reduction in power rate be even considered.

Load Factors, Cost of Irrigation, Water Duty, Etc.

Being that irrigation by electric power is comparatively new, and methods heretofore employed have not been of the best, it is impossible to give comprehensive data on costs, etc.; but we have the exact data on water supplied by the largest gravity canal in Central Washington, and data obtained from government reports compiling all of the gravity canals in the Yakima Valleys, which delivery or consumption factor is plotted out on curves Nos. I and II, respectively, and which canals irrigate some 150,000 acres. Also we have the same factor as obtained from two of the largest hydro-electric irrigation plants in the State of Washington



Curves of Consumption Factor.

as plotted out on curves III and IV, which, as the general usage is the same, enables us to deduce the load factors for the tables of charges, costs, etc., for the 1000 horsepower and 10 horsepower installation as herein quoted in connection with the irrigation power

rates quoted in previous paragraph, and which load factor from such sources obtained will hold good for the general system. These curves and load factor tables can be added to, or plotted on, the curves of any power company's annual load so as to see what the effect of the added irrigation power load would be upon their annual load factor, and the taking on of such load be governed accordingly with surprisingly satisfactory results. However, in the case of both the curves and load factors herein plotted and mentioned no account has been taken of daily load factor, so that in plotting out these curves on to an annual load curve great care should be taken in considering the effect of the irrigation curve upon the daily load curve of the power company that abrupt peaks should not result and affect the annual curve; and no contract for irrigation power should be taken without reserving the right of compelling the customer to cut down or cut out his use of power for, say three hours per day upon request, and especially with large consumers who are easier to reach than a lot of small ones. And while this restriction upon the customer may, perhaps, seem to him bothersome and unnecessary, in practice it might be exercised only on Saturday evenings when the lighting loads are the heaviest during the week. And as is shown from the curves, the maximum demand on irrigation comes in July and August, when the lighting loads are at an annual minimum. Altogether, I regard the holding of this privilege in a contract very necessary, because in the future, as irrigation loads become heavier, it may have more of a bearing—than we think now—upon the success of the power companies, and with such cheap power they could not afford to have much of a "summer hump."

1000 Horsepower Installation.

Month.	H.P. at 100% Monthly Load Factor.	Fixed Charges.	Running Charge.	Discount.	Total Monthly Fixed Charge.	Rate Per KW.-Hr. Incl. Total Annual Charge.
April ...	520	$2,000.00	$3,908.00	$1,293.00	$4,615.00	$0.0165
May	742	2,000.00	4,675.00	1,562.00	5,113.00	.0128
June ...	825	2,000.00	4,910.00	1,644.00	5,266.00	.0118
July	1,000	2,000.00	5,352.00	1,799.00	5,553.00	.0105
August..	1,000	2,000.00	5,352.00	1,799.00	5,553.00	.0105
Sept.	520	2,000.00	3,908.00	1,293.00	4,615.00	.0165
					$30,715.00	

From the horsepower column of which is obtained the following table of monthly ratio of delivery of water, based on the total delivery of 27 acre inches per acre.

April	3.16	acre ins.,	or 11.3% of total
May	4.5	acre ins.,	or 16.1% of total
June	5.0	acre ins.,	or 17.8% of total
July	6.07	acre ins.,	or 21.7% of total
August	6.07	acre ins.,	or 21.7% of total
September	3.2	acre ins.,	or 11.4% of total

Also the per acre cost of delivery of water by electric power to an elevation of 100 ft, in per acre season amounts from 18 to 36 ins. with a 1000 horsepower installation working at 76 per cent season load factor, with apparatus giving a wire to water efficiency of 65 per cent:

Acre Inches.	Average Rate of Delivery.	Acres Covered.	Total Season Power Cost.	Power Cost Per Acre.
18	1 sec. ft. to 240 acres	10,600		$2.90
20	1 sec. ft. to 220 acres	9,500		3.24
24	1 sec. ft. to 180 acres	7,900	$30,715.00	3.90
27	1 sec. ft. to 160 acres	7,000		4.40
30	1 sec. ft. to 140 acres	6,200		4.95
36	1 sec. ft. to 120 acres	5,300		5.80

10 Horsepower Installation.

Month.	H.P. at 100% Monthly Load Factor.	Fixed Charge.	Meter Charge.	Total Charge.	Rate Per KW.-Hr. Incl. Total Annual Fixed Charge.
January		$10	*	$10.00	
February		10	*	10.00	
March		10	*	10.00	
April	5.2	10	$39.06	49.06	$0.0212
May	7.4	10	46.75	56.75	.0167
June	8.2	10	49.10	59.10	.0155
July	10.0	10	53.50	63.50	.0135
August	10.0	10	53.50	63.50	.0135
September ..	5.2	10	39.06	49.06	.0212
October		10	*	10.00	
November ..		10	*	10.00	
December ...		10	*	10.00	
Total amount, 6 or 12 months.		$120.00		$400.97	

*Used for purposes other than irrigation.

From the horsepower of which is obtained the following monthly ratio of delivery of water based on the total delivery of 27 acre inches per season, which percentage delivery will hold good for any water duty:

April	3.16	acre ins.,	or 11.3% of total
May	4.5	acre ins.,	or 16.1% of total
June	5.0	acre ins.,	or 17.8% of total
July	6.07	acre ins.,	or 21.7% of total
August	6.07	acre ins.,	or 21.7% of total
September	3.2	acre ins.,	or 11.4% of total

Also per acre cost of delivery of water by electric power to an elevation of 50 ft. in per acre season amounts from 18 to 36 ins. with a 10 horsepower installation working at 76 per cent season load factor with apparatus, giving a wire to water efficiency of 57 per cent:

Acres Ins. Per Season.	Average Rate of Delivery.	Acres Covered.	Total Season Power Cost.	Cost Per Acre Season.
18	1 sec. ft. to 240 acres	180	$400.97	$2.23
20	1 sec. ft. to 220 acres	165	400.97	2.43
24	1 sec. ft. to 180 acres	135	400.97	2.95
27	1 sec. ft. to 160 acres	122	400.97	3.29
30	1 sec. ft. to 140 acres	105	400.97	3.77
36	1 sec. ft. to 120 acres	90	400.97	4.26

However, if water could be utilized in equal amounts during the months of the season so that a pumping plant could be operated at 100 per cent load factor for six months, then 7½ horsepower would do the work, making the table as follows:

Acre Ins. Per Season.	Monthly Per Cent of Total Delivery.	Acres Covered.	Total Season Power Cost.	Cost Per Acre Season.
18	16.66	180	$333.95	$1.84
20	16.66	165	330.95	2.00
24	16.66	135	330.95	2.45
27	16.66	122	330.95	2.71
30	16.66	105	330.95	3.16
36	16.66	90	330.95	3.68

Referring to the load factor tables and curves, it will be seen that, owing to the demand for more water, during the months of July and August the installations must necessarily be about 30 per cent larger than if water were used in the same amount constantly during the season, which would result in the customer getting water on the land somewhat cheaper and argue for the universal adoption of a flat power rate, but these conditions evidently do not exist.

The water duty, power required and per acre costs shown do not take into account distribution losses in the irrigation systems, which losses are entirely in control of the customer; and in modern, well constructed systems—especially the small ones—are negligible.

The power costs per acre specified in tables are easily capable of being obtained and maintained under the power rate quoted and are figured for a plant of 1000 horsepower delivering 100 ft., and the small plant of 10 horsepower at 50 ft., because these two lifts

are about what generally exist in the different sizes of plants. And while I admit that in case of the great majority of plants in operation today the per acre costs have greatly exceeded these specified, it has been wholly on account of the inefficiency of apparatus used. And to give an example of the difference of costs of power per acre per season (under the rates herein mentioned) of efficient and inefficient apparatus under a 50 foot lift, take "A" for instance whose over-all efficiency is 57 per cent and "B" whose over-all efficiency is 30 per cent, then "A" pays $3.29 per acre season for 27 acre inches delivered in the right season ratio, and "B" pays $6.25, or nearly double.

[To be continued.]

ELECTRICAL ENERGY IN MANUFACTURE OF FERTILIZERS.

The visit of Dr. Samuel Eyde to the Coast brings up at once the present status of the electric fixation of atmospheric nitrogen, and the use of calcium cyanamid and calcium nitrate on soils. The Bureau of Soils of the Department of Agriculture has collected in bulletin No. 63 a comprehensive summary of this most profitable and promising field for future utilization of gigantic water-powers as an aid in replenishing depleted soils.

For many years it has been the aim of inventors to devise means of utilizing the vast store of nitrogen in the atmosphere. Two practical motives have been operative:

First, the enormous development of engineering and structural work calls for a largely increased manufacture of high explosives at a moderate price. Incidentally the modern art of war calls for explosives of high power in no mean amount. For these purposes oxidized nitrogen in some suitable carrier seems to be accepted as the most practical basis agent.

Second, the more or less rapid development of intensive methods of agriculture throughout civilized lands warns us that a reliable supply of nitrogenous soil amendments or fertilizers must be found. Up to the present our main supplies of nitrogenous fertilizers have been natural deposits of niter (principally Chilean saltpeter), ammoniacal waste liquors of gas works and coke ovens (ammonium sulphate), animal refuse and slaughterhouse products, such as tankage, animal manures including night-soil, and green manures of leguminous and other crops. None of these has yet been exploited to its full limit, and to predicate the adequacy of any or all of them for the future is to speculate aimlessly, for there are not sufficient data to justify confidently any computations. The fact remains, nevertheless, that experience is showing so high a cost for nitrogen in the common available fertilizers, many of which also present undesirable features in their handling, that new nitrogenous fertilizers are desirable.

The desire to obtain a cheap and inexhaustible supply of nitric acid, primarily for the manufacture of high explosives, and secondarily to augment the world's supply of available nitrogenous fertilizers, has led within the last decade to the commercial production of two substances well suited to the latter end. These are basic calcium nitrate and calcium cyanamid. Both have been repeatedly tested as practical fertilizers, and in both cases favorable and unfavorable results are on record, as is true of any fertilizers. On the whole, however, they seem to have won a definite recognition as valuable fertilizers.

The manufacture of these products on a commercial scale depends on an ample and cheap supply of lime or limestone and on a cheap source of power, for both require the employment of high-power electric current. The first condition can be met with relative ease. The second is really the limiting condition for economic production. So far cheap water powers have almost exclusively claimed consideration, but as cheap water powers in accessible localities are rapidly disappearing, there appears to be a tendency to consider the possibilities of "producer gas" where it is developed in sufficiently large and continuous quantities in connection with some other industry, as for instance in large steel works.

The first important commercial production of nitric acid from atmospheric nitrogen was at Niagara Falls, by the Bradley-Lovejoy process. Essentially the process consisted in passing air, or air somewhat enriched with oxygen, through a rapidly alternating high-tension electric spark. Fortunately for the stability of our atmosphere, the "kindling temperature" of nitrogen is very high, else a thunderstorm might destroy the world. With the sparks obtained by the Bradley-Lovejoy method, some oxidation of nitrogen was secured, and by absorbing the burned or sparked air in water nitric acid was obtained. The life of this factory was, however, brief. About the same time the Birkeland-Eyde process was developed at Notodden, in Norway, where a much cheaper water power and large supplies of limestone were available. This process differed from that of Bradley and Lovejoy in that the electric spark was spread out by being developed between powerful magnets, thus giving a much larger surface of action upon the current of air which was forced through the spark. The sparked air was then absorbed in water by means of towers similar to the ordinary Gay-Lussac towers of the sulphuric-acid factory. In this way a low per cent nitric acid could be manufactured under exceptionally favorable circumstances. But it was soon found advisable, from a commercial point of view, to absorb this acid in an excess of lime or lime water, thus producing a mixture of lime and lime nitrates and nitrites, of which the principal component seems to be the definite compound

$$2CaO\ N_2O_3\ 3\tfrac{1}{2}H_2O$$

a true basic lime nitrate. This substance soon found favor as a nitrogenous fertilizer, especially in Northern Germany, and practically all the product of the Notodden factory has gone to that locality for fertilizer purposes, although it is generally understood that it was the intention of the operators in Notodden to develop the method to the point where a concentrated nitric acid could be commercially prepared for the manufacture of high explosives.

Still more recently another method has been developed for the production of nitric acid by the oxidation of nitrogen, this method being controlled by the well-known manufacturers, the Badische Anilin und Soda-Fabrik. In this process a continuous arc is produced in a long tube by first bringing electrodes together and then gradually moving one of them along the tube

while the other remains fixed at one end of the tube. The current of air instead of being passed through this arc is passed around it through the tube by being forced in at an angle to the main axis of the tube. It is said that the arcs used in this process vary from 30 to 50 feet or more in length, and are maintained continuously for days or even months at a time. The gases passing from the tube are absorbed in water and give a much higher concentration than those produced by the Birkeland-Eyde process, some of the statements appearing in the current descriptions claiming that an acid as high as 30 per cent is formed.

Another method for producing nitric acid by the burning of air which has been attracting some attention recently, and which appears to contain great promise, is that known as the Rankin process. The peculiar features claimed for this method are that they use a "fat" spark produced by a current of far lower tension than that employed in the Bradley-Lovejoy or the Birkeland-Eyde processes, and employ electrodes of peculiar construction, the cathode being a hollow iron contrivance through the interior of which is passed continually a current of cold water, while the anode is a substance of secret composition which is said to ionize the air particles as they approach the spark. The claim is made for this process that the solution obtained by absorbing the gases in water passed through a specially constructed cooling device is a nitric-acid solution of a considerably higher concentration than that produced by the other processes. It is not possible at present to state how far the Rankin method has become a commercial one, as in many of its details it is what is known as a secret process, and the operations of the company controlling it are not accessible to the public. It can be stated, however, that marketable quantities of high-grade nitric acid have been produced by this process, and that it, like the others described above, is mainly dependent upon the procurement of cheap power.

An interesting feature of the work of this company is that they at one time proposed to utilize their acid in the manufacture of super-phosphate, which would, of course, contain basic calcium nitrate instead of gypsum.

Lime nitrogen or calcium cyanamid utilizes the atmospheric nitrogen in a manner which, chemically at least, is distinctly different from the processes described above. Calcium carbide is made by heating in an electric furnace a mixture of lime and carbon, or some highly carbonaceous matter, such as coke screenings, tarry residues, etc. If, now, the process is carried further in an electric furnace of special construction, and a current of nitrogen or air rich in nitrogen is passed over the highly heated carbide, a chemical reaction takes place. If the heat be sufficiently high and prolonged, calcium cyanide is formed,

$$Ca(CN)_2$$

but if a somewhat lower temperature be maintained, the product is mainly calcium cyanamid.

$$CN_2Ca.$$

The calcium cyanide is a valuable starting point for the production of compounds. Calcium cyanamid finds a number of uses in chemical industry; as, for instance, a starting point in the production of guanadin derivatives, use in case-hardening steel, etc., but is mainly used as a fertilizer. It has been claimed as an advantage to the process that Messrs. Frank and Caro, the original inventors, have further devised a scheme for producing nitric acid, starting with cyanamid as the raw product and employing a contact method, but so far the details of the process have not been made public, and it does not as yet seem to have been employed in a commercial way.

What takes place when calcium cyanamid is added to the soil has not yet been definitely settled. The raw substance appears to be toxic to most of our common crop plants, but it more or less quickly undergoes decomposition and changes in the soil, probably with the production of nitric acid through bacterial and other activities, and thus becomes available to the plants. It should be observed, therefore, that calcium cyanamid is not to be regarded as a substitute for or as playing the same role in the soil as sodium nitrate, but rather as simulating the ammoniacal salts, tankage, etc. Its advantages over these substances as fertilizer are its cheapness, ease of handling, storage, and generally better mechanical properties. In these respects it seems to have a distinct advantage over the basic calcium nitrate produced by the various processes of oxidation of nitrogen, for the latter is a markedly hygroscopic substance, the handling thereof and the selection of proper containers therefor being important problems in its commercial exploitation.

EXPANSION OF NITRATE INDUSTRY.

The current consular reports give interesting figures of the present status of the nitrate industry in Chile. In view of the discussion elsewhere in this issue on electrical methods for production of calcium nitrate this data will prove valuable in comparison and is as follows:

The outlook for the nitrate business promises exceptionally well both in price and consumption. The past nitrate year ending June 30 was prosperous, with a production of 2,469,000 tons, against 2,459,000 tons for the previous year, and on a rising market of fully 10 per cent for the year. With the new nitrate works to be opened it is estimated that the output for the nitrate year ending June 30, 1913, will show a marked increase, since the visible supply on June 30, 1912, was 33,000 tons less than at the same date last year.

The world's consumption of nitrate for the last nitrate year broke the record by 36,000 tons and exceeded the production. Apparently there has been quite a decline in the consumption of nitrate of soda in the United States during the past three years, while other parts of the world show good increases, as may be seen from the following table:

Countries.	1910 Tons	1911 Tons	1912 Tons
Continent of Europe	1,530,000	1,585,000	1,711,000
United Kingdom	118,000	129,000	132,000
United States	516,000	535,000	503,000
Other countries	78,000	85,000	114,000
	2,242,000	2,324,000	2,460,000

WATER POWER PERMITS.

The United States government has formulated rules and regulations governing the acquisition of power sites under the act of February 15, 1901. Western land offices are in receipt of the regulations approved August 24, 1912, the same comprising a pamphlet form of some 20 pages.

JOURNAL OF ELECTRICITY
POWER AND GAS

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., OF JOURNAL OF ELECTRICITY, POWER & GAS, Published Weekly at San Francisco, required by the Act of Congress of August 24th, 1912.

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Signed. A. H. HALLORAN.

Sworn to and subscribed before me this 3rd day of October, 1912.

(Seal.) J. W. COOK, Notary Public,

In and for the county of San Francisco, State of California.
(My Commission expires Dec. 20th, 1915.)

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Changes of advertising copy should reach this office ten days in advance of date of issue. New advertisements will be accepted up to noon of Monday dated Saturday of the same week. Where proof is to be returned for approval, Eastern advertisers should mail copy at least thirty days in advance of date of issue.

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Investigations on Synthetic NitrogenProducts

The possible use of synthetic nitrogen products as fertilizers in varying soils is of commercial importance to the agriculturist and to the power expert. To the agriculturist it means a new replenisher of depleted soils to replace the possible exhaustion of the present natural supply. To the power expert, it means an enlarged utilization of vast natural water powers.

It is imperative that experiments be undertaken in the West to determine the comparative merits of nitrate of soda, the natural fertilizer found in nature, and nitrate of lime, the recently invented synthetic nitrogen product now proving so profitable in Norway as an electrical process for utilizing the nitrogen of the air.

Chas. B. Lipman, soil expert of the agricultural experiment station at the University of California, is preparing to undertake such investigation as outlined above with samples shipped from the Eyde plant in Norway. Hitherto, Mr. Lipman has made noteworthy and original strides in investigations of the fixation of atmospheric nitrogen by means of plant life, consequently the results of his new labors will be watched by the hydroelectric fraternity with the keenest interest.

Gigantic Powers for Nitrogen Products

Of intense interest to Coast hydroelectric companies is the present visit to Seattle and San Francisco of Dr. Samuel Eyde of Christiana, Norway. Dr. Eyde is the head of the nitrogen industries of Norway, and the inventor of the system of utilizing nitrogen from air, which is now in practical use in Norway.

At present the world's supply of nitrates used in fertilizers are mined in the saltpeter beds in Chile. Rich and extensive as these deposits are, nevertheless, experts declare the present rapid rate of consumption will exhaust the supply within the next sixty years. The chemical combining of free nitrogen of the air in commercial quantities has for years baffled scientists. Indeed, the process so efficiently brought into action by certain organic growths has been enviously sought after for a century. A hundred years ago the electric spark was first found to aid in the formation of chemical products from the inert nitrogen of the air. As a commercial success, however, it was not until 1903, that Dr. Eyde employed two men in the first production of nitrogen products by his process. Today the Norway plant at Rjukanfoss employs 1000 men and has a production of 70,000 to 80,000 tons of nitrate of lime annually, together with thousand of tons of by-products.

Synthetic nitrogen fertilizers are produced under the Eyde system by the use of fans and the driving of the air through the so-called Birkeland-Eyde oven, where it is heated by an electrical flame. The oxygen and nitrogen are there combined in water to make nitric acid. With calcium carbonate, which may be found in immense deposits in the West, nitrate of lime is there formed which, in many finer fertilizing qualities, even excels the famous sodium nitrate found

in Chile and now universally used for aid to plant growth. Aside from nitrate of lime, the air plants of Norway produce other valuable nitric by-products, including ammonium nitrate, wrich is manufactured for explosives; nitrite, which is used in the manufacture of aniline dyes; and concentrate nitric acid, which has many uses in the chemical industries.

The Norsk Hydro-elektrick Kvoelstofak-tieselskab, the company which operates the plant utilizing Dr. Eyde's process and which has a capital of $30,000,000, is making improvements and adding to the annual production as fast as possible.

A site is now being looked into as a possible base to supply the products to America and the countries bordering on the Pacific. Four things are necessary for the ideal location—abundance of cheap power, water, calcium carbonate and a profitable market. It is stated that a plant of proportions desired would utilize 200,000 horsepower and employ a thousand men. It is certainly true that if any place in the world cheap power is to be found, it is in the great water powers of the West. Water necessary as an absorbent in the making of nitric acid will thus be simultaneously available in required quantities. As for calcium carbonate, nature has lavishly shown her hand in distributing these deposits in unlimited supply in our coast commonwealths. The market for these products finally, is unquestionably to be found in our Western Empire, where agricultural pursuits will eternally necessitate the fertilizing of depleted soils in years to come. A ready market, too, will be found among the isles of the Pacific and throughout North and South America, so soon to be entirely approachable via Pacific Coast ports and the Panama Canal.

Summing up the entire situation, then, it would seem that ideal conditions are found here in the West for utilization of gigantic powers in the manufacture of synthetic nitrogen products. The West would welcome Dr. Eyde and his installation. But whether or not his particular investigation will prove it to be a wise and feasible move to locate a plant in the West, at present is of small moment, for the fact remains that someone sooner or later will realize the opportunities presented and the unquestioned future market here to be found. Another new and bright sky is thus before tne West for the utilization of its gigantic natural blessings in the way of unsurpassed water powers.

Electric Power vs. the Human Pump.

It is surprising to note the unprecedented growth in the utilization of electrically operated pumps during the past year in the arid sections of the West. Even in those districts where water is as a rule plentiful, due to kindly and seasonal rains, the farmer finds it to his advantage to have a "friend in need" in the way of the electrically operated pump ever ready for an emergency or a chance disappointment in the foretelling of approaching rains by the weather man. A striking illustration of this gigantic growth is seen from the present load conditions of such coast companies as the Pacific Power & Light Company of Oregon, the Pacific Gas & Electric Company and the Great Western Power Company of central California, and the Southern California Edison Company in the southern section of that commonwealth. In each of these companies, whereas two years ago the pumping load in rural communities was an inconsiderable item, today no less than 25,000 h.p. of installed capacity in electrically operated pumps are to be found, the average unit being from 10 to 20 h.p. Other companies could equally well be mentioned in the list above. To show the extreme limit of application in the pliable, electrically operated pump, the Mt. Whitney Light & Power Company in the upper San Joaquin Valley finds that it can profitably supply power to one of its rancher consumers to lift water, for irrigation purposes, a total height of 476 ft. vertical.

In the present reawakening of China visitors returning from that ancient civilization are loud in their praise for many economic agricultural wrinkles widely in vogue there, but wholly unknown in this country. Many had previously heard of the river boats propelled in their native streams by the Chinese. The classic stern wheels of these boats are often actuated by the Chinamen themselves climbing treadmills attached to the stern wheels. Few, however, had dreamed of the application to irrigation of this method of raising water though this latter application has antedated the former in China probably by hundreds of years.

Let us for a moment discuss this method of power generation in this ancient civilization, which has produced such eminent teachers, religious leaders and inventions. According to Harrington Emerson, experience has thoroughly demonstrated in the treadmills of British prisons, that year in and year out, an average human being operating a treadmill can climb 8640 ft. per day. As the average human being weighs 150 lb., this is equivalent to 1,296,000 ft. lb. per 24 hr. One horsepower in. 24 hr. will produce 47,520,000 ft. lb. of energy. Calling now, our new power unit, the "chink," it is seen at a glance that 36.6 "chinks" are equivalent to a horsepower. In China today is to be found perhaps the lowest wage scale in existence. In order, then, to give the treadmill pumping plant its most economic cost of power production, let us compute costs of operation and power generation on the basis of 10c per day for human labor. A horsepower of energy would thus cost $3.66 per day or $1336.00 per year. In the arid west, power may be had in abundance for steady pumping operations at $50.00 per hp. per yr. In the ultimate it will undoubtedly prove true that $25.00 per year or less will prove profitable. But at $50.00 per hp. per yr., it is seen that electric power may be delivered at less than one twenty-fifth the cost of production by the cheapest labor on earth.

Compare now the wage conditions of the two types of men directing the generation of power as set forth above—the one gets 10c per day for his labor, the other $3.00 per day or more; the one represents a limited supply of human endeavor, which might by human intrique be monopolyzed, the other is bounded by the limits of the heat and warmth of the heavens, and only the Almighty himself can ever be said to control the supply.

PERSONALS.

H. B. Day, a telephone official of San Diego, is a recent San Francisco visitor.

S. C. Gillespie, valuation engineer of J. G. White & Co. of New York, is visiting Los Angeles on business.

R. M. Alvord, local supply manager of the General Electric Company, has returned to the San Francisco office after an extensive Eastern trip.

W. L. Goodwin, manager of the Pacific States Electric Company, has been spending a week at the Los Angeles branch, where business is very good.

Thomas A. Cashin has taken up his duties as superintendent of municipal railways, in connection with the Geary-street electric road, which is nearing completion.

J. E. Crilly, who is connected with the office of the Holabird-Reynolds Company, is en route to Honolulu on the steamer Sierra and will spend a well-earned vacation in the Hawaiian Islands.

R D. Holabird, president of the Holabird-Reynolds Company, recently returned to San Francisco from Seattle and **E. J. Dwyer**, of the same firm, is spending a few weeks at the northwest branch house.

Robert Reid has recently resigned his position with the Pacific Gas & Electric Company and is returning to the Hawaiian Islands, where he will be engaged as power superintendent in a small hydroelectric plant.

H. M. Hepburn, general manager of The Hawaiian Electric Company, Inc., recently sailed for Honolulu, after having spent some time in visiting Eastern central stations and electric manufacturing works while gathering information.

Wynn Meredith of Sanderson & Porter, who recently returned to San Francisco after making an inspection of the progress of the work on the General Petroleum Company's pipe line, will leave for Victoria, B. C., early next week.

A. J. Turner, of the commercial department of the Great Western Power Company, has been elected secretary of his university class, to fill the position made vacant by the recent deplorable death of his classmate, Jas. H. Wise. Mr. Turner graduated from the University of California in 1903.

A. W. Bullard, general manager of the Great Western Power Company, accompanied Mortimer Fleishhacker, president of the same company, and H. P. Wilson, vice-president of the Western Power Company on an inspection trip to the Big Meadows dam and the power plant on the Feather River during the past week.

Gerald Deakin, formerly chief engineer of the Bay Cities Home Telephone Company and recently automatic plant engineer of the Pacific Telephone & Telegraph Company, has left for New York on his way to Europe to take up the development of automatic telephone apparatus for the Bell Telephone Manufacturing Company of Antwerp. Mr. and Mrs. Deakin expect to reside in Europe for the next three to five years.

Dr. Samuel Edye, inventor of the Birkeland-Eyde process of electrically forming synthetic nitrogen products from the air, is a recent San Francisco and Seattle visitor. Dr. Eyde is visiting the west with a possible view of establishing a plant similar to his Norway installation. It is said that such a plant would utilize 200,000 horsepower and employ 1000 men.

M. L. Scoby and B. Badrian, with the Pacific States Elecric Company, have returned to San Francisco after spending some time in charge of an attractive exhibit of various electric appliances at the State Fair at Sacramento, and, later, at the Stanislaus County Fair at Modesto. A gold medal was received at Sacramento and a blue ribbon, for the best exhibit at Modesto.

R. S. Buck of Sanderson & Porter's Pacific Coast branch office, is visiting New York City at the request of the municipal authorities so as to be of assistance in some adjustment in connection with the East River bridges. Buck was chief engineer of the Department of Bridges during the construction of the Blackwells Island bridge and of the Manhattan bridge. He also planned four bridges at Niagara Falls.

F. G. Baum, of F. G. Baum & Company, who has been for some years consulting engineer for the Pacific Gas & Electric Company, will, in future act for that corporation in a larger capacity. It is understood that he will have special charge of the construction of the Lake Spaulding dam and of the tunnel work of the Bear River, or South Yuba development. Mr. Baum recently returned to San Francisco after visiting South America.

J. L. Crider, who has been general superintendent of construction with J. G. White & Co. for the Oakland and Antioch Railway work, is now in general charge of the construction on the Oakland, Antioch and Eastern in addition to the above-mentioned road. **C. H. Quimby** has joined the Pacific Coast force of J. G. White & Co. as assistant to J. L Crider, in following up the general construction work on the Oakland and Antioch. He recently arrived at San Francisco from the East, where he has been connected with important engineering work.

E. B. Bumsted, who was formerly connected with the engineering department of the Stone & Webster Engineering Corporation and the Stone & Webster Construction Company, has been appointed vice-president of the Oro Electric Corporation and placed in charge of the departments of operation and construction. The company has been increasing its force, in anticipation of expending more than $5,000,000 on a new hydroelectric plant within the next two years. It is the intention of the management to begin construction work at once on the new Yellow Creek development of 60,000 h.p. The plant, located at the junction of Yellow Creek and the north Fork of the Feather River, will use a high head of water exceeding 2000 feet. Mr. Bumsted is well equipped for this work, having been connected with hydroelectric enterprises for fourteen years. He was connected with the construction of the St. Lawrence River Power Company's large plant and was afterwards general manager.

OBITUARY NOTE.

Lorenz Davenport Hitzeroth, who was long connected with the electrical business at San Francisco, died October 1, leaving a wife, Mary Hitzeroth, and a son, Lorenz C. Hitzeroth. Funeral services were held October 3, at Mission Masonic Temple, under the auspices of Mission Lodge, No. 169, F. & A. M.

TRADE NOTES.

The Westinghouse Electric and Manufacturing Company has been awarded the contract for the main generators and other alternating current apparatus for the Pacific Gas and Electric Company's two power houses that are being constructed to utilize the waters of Bear River in connection with the Lake Spaulding reservoir. The specifications call for 4 water wheel-type generators, each rated at 12,500 k.v.a. A Westinghouse representative says that the design of the machines has been perfected to a point where they can guarantee a runaway speed of twice the normal speed. Each water wheel is rated 8500 h.p. and of the double overhung type, making 17,000 h.p. per unit.

The Pacific Gas and Electric Company also ordered from the Crocker-Wheeler Company two railway motor generator sets, one of which is to be installed at Oakland and the other at Sacramento. The requirements indicated by the specifications are very high. Each machine has a capacity of 1000 kw. On the primary the voltage is 11,000, 60 cycles, at 514 r.p.m., while the secondary is 600 v., direct current.

ELECTRICAL CONTRACTORS' NOTE.

The General Electric Construction Company was awarded the wiring for the new State Armory at 14th and Mission streets. The cost was estimated at about $8000.

The Newberry-Bendheim Company have about completed the wiring at the Presidio Hospital and have commenced installing conduits in the Standard Oil Building.

P. Decker, who was sick at Thomas' Sanitorium for about three weeks, has improved and returned home.

It is reported that the Tivoli Opera House will go ahead, as a loan has been obtained by the management.

The joint Board of Police and Fire Commissioners ruled at a recent meeting to the effect that in the future metal troughs should be allowed for the outlining of buildings and in Marquises. This is contrary to the rules of the National Board of Fire Underwriters, and really a step backwards. Metal trough was good construction before the day of the conduit and such fittings, but today, with the convenient fittings that the manufacturers have placed at our disposal, it is but a makeshift and favored only by people engaged in the sheet metal business. No up-to-date electrical man would specify anything except conduit work for decorating. With reference to Marquises, the writer sees no objection to enclosing the wires in the frame of a Marquise, as a better job can be done and the life of the Marquise is the life of the job.

The Starr King School will be out for figures in a few days. Architect John Reid Jr. has notified the contractors that the bids will be segregated.

The California State Electrical Contractors' Association is working hard at raising funds to aid their State license law that they expect to bring before the State Legislature this winter.

Fred Fisher's bid of $55,100 was accepted for the general construction contract on the Service Building at the Panama-Pacific Exposition. The Central Electric Company's bid of $1700 was the lowest on the wiring.

NEWS OF CALIFORNIA RAILROAD COMMISSION.

September 28.

The Pacific Gas & Electric Company applied to the Railroad Commission for permission to build a spur track across a county highway in Placer county, to be used in connection with hydroelectric development work.

September 30.

The Railroad Commission set October 16 for the hearing of the induction cases. The Pacific Telephone & Telegraph Company filed four complaints; one against the Sierra & San Francisco Power Company alleging interference with the lines in Santa Clara and Monterey counties; one against the Coast Counties Gas & Electric Company alleging interference in Santa Clara and Santa Cruz counties; and two against the Great Western Power Company alleging interference in the section north of San Francisco Bay. The telephone company requested that the power companies be compelled to move their high-tension wires from 700 ft. to 2000 ft. from the telephone lines.

October 1.

The Railroad Commission rendered a decision establishing a through route and joint rates between the Central California Traction Company and the Atchison, Topeka & Santa Fe Railway Company. The Central California Traction Company operates between Sacramento and Stockton, a distance of about seventy miles, and connects at Stockton with the Santa Fe.

A hearing of importance to telephone users and to telephone companies was set for October 7, at which time the Commission will have under consideration the proposed new system of toll rates of the Pacific Telephone & Telegraph Company.

An order was issued by the Commission granting authority to the Collins Commercial Company to extend wires across Palm street and Bay avenue, at Newport Beach.

October 2.

The Northern Electric Railway Company applied for permission to issue $8,000,000 of 5 per cent bonds, of which $5,500,000 will be sold to complete the company's line from Sacramento to Vallejo. The balance will be reserved for such issuance or exchange as may later be determined.

The Commission granted the application of the Mt. Whitney Power & Electric Company to put into effect a new form of meter contract for power, providing for a minimum of $24 per year.

R. H. Gaud and the Santa Barbara & Suburban Railway joined in a petition asking that the former be allowed to transfer to the latter his street railway franchise in Santa Barbara. The Santa Barbara & Suburban Railway Company also asks for a certificate of public convenience and necessity allowing it to operate under this franchise.

The Great Western Power Company applied for a certificate of public convenience and necessity to exercise franchise rights in the towns of Suisun, Fairfield and Dixon, and for the sale of electricity.

ELECTRICAL DEVELOPMENT LEAGUE MEETING.

The regular monthly meeting of the Electrical Development League of San Francisco was held October 8th. Considerable discussion took place relative to the inefficient and arbitrary regulations at present in force in San Francisco with respect to electric installations, and particularly the discriminatory laws existing with respect to the use of flexible steel conduit and steel armored conductors. A committee of nine, consisting of Messrs. C. C. Hillis, L. Levy, L. R. Boyton, G. I. Kinney, C. C. Davis, W. W. Hanscomb, N. W. Reed and a representative from each of the Central Stations, was appointed to take up the subject with the city electrician and if necessary the Board of Supervisors, looking toward a revision of the present laws and consultation on any future municipal legislation.

Messrs. A. W. Bullard, E. B. Strong and Stanley Walton were appointed delegates to the Boston Electric Show September 28th to October 26th.

The subject of consolidation of the various electrical organizations, i.e., Sons of Jove, Energy Club and Electrical Development League, was considered and a committee of three consisting of Messrs. Holberton, Vandegrift and Halloran appointed to consider the advisability and possibilities of such action.

At the conclusion of the business session the members were treated to an interesting paper on "Readiness to Serve Methods" by Ross B. Maters of the Great Western Power Company.

JOVIAN LUNCH CLUB AT PORTLAND.

Forty members and guests met at the Hazelwood Thursday, the 3d, for 12:15 p. m. lunch. The speaker of the day was F. J. Lonergan, who gave an exceedingly interesting talk on "Defense of the Portland Railway, Light & Power Company's position in regard to the franchise granted by the City Council to the Northwestern Power Company."

OREGON SOCIETY OF ENGINEERS.

The Oregon Society of Engineers, through their legislative committee, of which F. D. Weber is chairman, is making a determined protest against the passage of a "special permit" by the City Council of the City of Portland, Oregon, for the addition of another story to the three-story frame building located at the northwest corner Fourteenth and Market streets, which would be in direct violation of Section 119 of the Building Code of the city.

THE ELECTRICAL CONTRACTORS' DEPARTMENT

WIRING REQUIREMENTS AT PORTLAND.

(Continued.)

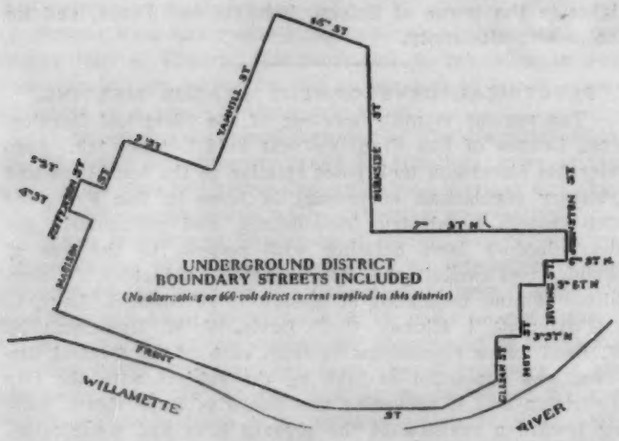
Underground District.

The Portland Railway, Light & Power Company operates a 3-wire direct current distribution system of 120 and 240 volts approximately (Edison Standard). (No alternating current or 500-volt direct current can be supplied in the underground district.)

Wiring.

(See general requirements, Division 1, Sections A, B and C.)

(a) In the underground district, the company will, in most cases, at its own expense, install, in metal boxes and conduit, in the basements of the buildings, all switches, cut-outs and wires up to the meters, unless the arrangement or



occupancy of the basement will not permit the location of the meter board at the point of service entrance, in which case the wiring contractor will be required to extend the service mains, at the building owner's expense, in metal conduit from the point of service to the meter board, which in most cases will be furnished and installed at the desired point by the company, together with all wiring on the board ahead of the meters. If the building has no basement or is located east of the high-water line of 1876 and 1890, some different and special method of making the service connection will be pursued.

(b) In any case where the company brings its service into the building, it will provide and install in its switch cabinet the elevator motor switch and cut-out, and the exit light switch and cut-out, as called for by sections 723½ and 788 of the Building Code of the City of Portland. All circuits leaving this switch cabinet must be carried in continuous metal conduit to the meter board, except that where necessary to install pull boxes, approved outlets with blank metal covers may be used.

(c) Owners, architects, contractors and others are herewith advised and warned that the company must be notified in writing when plans are being drawn for any building, so that its engineers may co-operate with the proper party in deciding on the point of service entrance and the location of the meters.

The company also requires this advance notice so that it may be prepared to install the above mentioned apparatus without delay when the proper time to do so arrives.

The company will not be responsible for delay in making the service connections when such notice is not given, and reserves the right to refuse to supply service unless the above requirement is complied with.

(d) Attention is called to Board of Fire Underwriters' Electrical Circular No. 17, of October 22, 1909, of which the following is an extract:

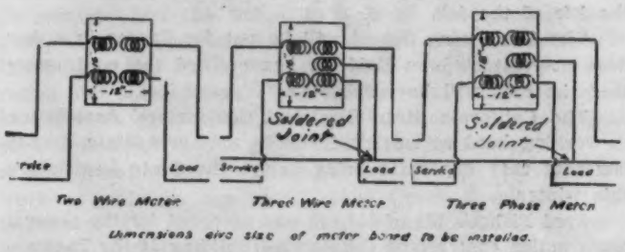
"All switches and fuses in basements to be placed in approved cabinets, as they are generally exposed to mechanical injury, the piling of stock, etc.

"A fuse on the customer's service is entirely unnecessary where the Portland Railway, Light & Power Company has installed one directly ahead of his (the customer's) meter.

"We suggest that the cabinet containing the customer's service switch be placed on the basement ceiling wherever feasible."

(e) Customers' switches must not be installed on company's meter board, and customers' conduit should terminate at top of board and the wires be carried down to the meter in loom. The loom to be fastened to the board with metal straps.

DIAGRAM OF WIRING FOR METERS IN OVERHEAD DISTRICT
(This also applies to Supplementary Meters in the Underground District)



(f) All meter loops installed by the wiring contractor for supplementary meters must be arranged for left-hand service, as shown.

Motors.

(a) Motors of less than one horse power must be a 110-120 volt direct current type, except as provided in (c).

(b) Motors of one horse power and over must be a 220-240 volt direct current type.

(c) Where the total connected load is one horse power or more, the voltage of all motors may be 220-240 volts.

(d) Where the total connected load is less than two horse power the motor or motors may be connected to the lighting meter.

If the total load is two horse power or over the wiring must be arranged for a separate meter for the motors.

Batteries.

In wiring for installations in which the load will consist of storage batteries which are to be charged direct from the company's 120-240 volt direct current Edison system, the wiring connections must be arranged and made, so that, at any instant, one-half (½) of the load will be connected to the positive side of the 3-wire system, and the other half of the load to the negative side, thus providing a balanced load. To insure as far as possible that the load will be connected as specified above, a 3-wire bus must be run around the charging rack or platform, and alternate receptacles for taps to batteries, must be connected to the positive and negative busses, respecitvely.

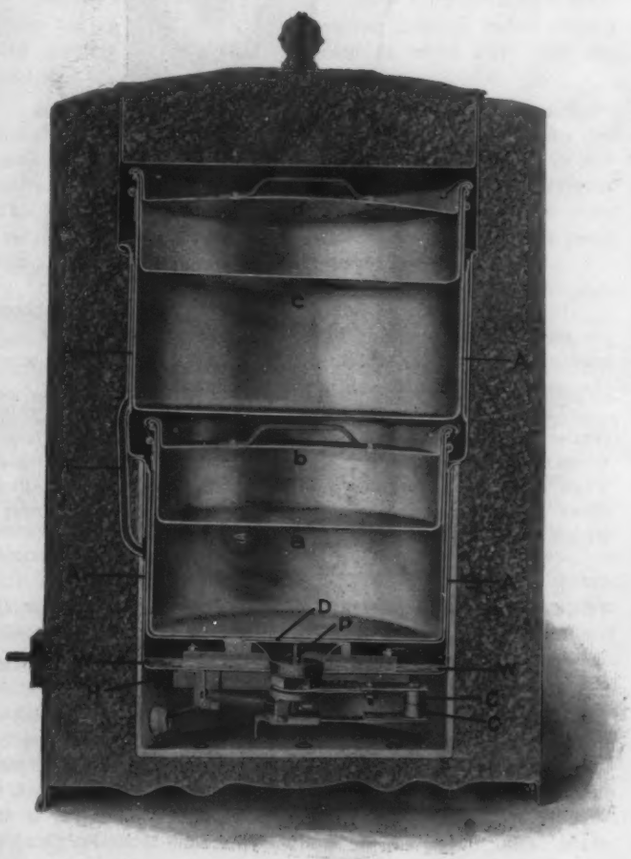
The company reserves the right to refuse to supply service unless the above requirement is complied with. It also reserves the right to discontinue service to an installation that has been connected, if the batteries are not connected as specified above.

INDUSTRIAL

AN ELECTRIC FIRELESS COOKER.

The Berkeley Electric Cooker Company had an interesting exhibit at the recent convention in Berkeley, Cal., of the League of California Municipalities. This exhibit is shown in the illustration. In this illustration is seen the picture of one of the electric cookers which without perceptible deterioration has already been in continuous operation for a year and a half.

This improved electric cooker consists of a double-walled copper vessel (marked A) with a small quantity of water in the bottom (marked W), and the switch mechanism operated by pressure of steam on a diaphragm (D), which pushes the pin (P) and opens the switch contacts at C, as shown in the illustration. The water is heated by the nichrome heating element (H), and the steam from this water completely fills the interior of the steam oven. In this way the distribution



Sectional View Electric Cooker.

of heat is accomplished. When the pressure of the steam rises to about ten pounds per square inch, the spring in the diaphragm (D) is overcome and it drives the switch contact open with a quick break.

Food is placed in the compartments A, B, C and D, and an entire meal may be cooked at one and the same time.

The stove is economical in cost of operation; automatic in its temperature control; without adjustments in controlling mechanism; made with an efficient heat conducting and distributing system between the electrical heat units and food receptacle, and made of enduring material that will stand continuous use for over a long period of time.

With such a device one may cook food by a process that is convenient, clean, efficient and economical.

FIVE NEW EDISON MAZDA LAMPS.

For 100-130 Volt Circuits.

Previously the only round bulb Edison Mazda lamps available for this circuit were the 15, 25, 40, 60, 400 and 500 watt sizes. On October 1, 1912, the General Electric Company added two new intermediate sizes, namely, the 100-watt and 150-watt sizes. This addition gives the user nearly the same wide range of sizes now available in the standard, or pear-shaped, bulbs.

Concentrated Light Source Mazda Lamp.

Another new lamp, whose successful production marks a decided advance in the manufacture of metallic filament lamps, is the Concentrated Light Source Edison Mazda Lamp, also standardized October 1st. This lamp is equipped with a concentrated filament and will be used on 100-130 volt circuits wherever a concentrated light source is desired, especially in projecting machines in homes and for general advertising purposes. The difficulties overcome in designing this lamp can be appreciated when one considers that a standard straight bulb Mazda lamp for this voltage would require a filament approximately three feet long. In order to obtain the necessary concentrated light source in the new lamp, this length of drawn wire filament is formed into a helix of small diameter somewhat resembling a closely coiled spring. This "spring" is then mounted or coiled together in a space approximately ½ in. each way, thus giving a greatly concentrated light source. The lamp operates at the high efficiency of 1.23 watts per mean horizontal candle power. It is designed to give a life of approximately 250 hours at rated efficiency. The round bulb, known as the G-30, is 3¾ in. in diameter and 6⅛ in. over all. Because of its concentrated light source, this lamp is especially adapted for use with either a parabolic reflector or a lens in projecting machines and for advertising purposes.

For 200-260 Volt Circuits.

Formerly the only round bulb Edison Mazda lamps available for this circuit were the 40 and 60-watt sizes. On October 1, 1912, the General Electric Company added two other sizes, namely, the 25 and 100 watt. Where round bulb lamps of this voltage are required the addition of two new sizes gives users a widely useful range of sizes from 25 to 100 watts, inclusive.

OREGON ELECTRIC RAILWAY COMPANY CATENARY.

In 1907 the Oregon Electric Railway Co. constructed their present main line connecting Portland and Salem, a distance of approximately 50 miles. A 71-mile extension from Salem to Eugene is now being built. Fig. 1 shows a view of the overhead construction on which catenary is used throughout. The original installation used a design of catenary hanger to support the trolley wire from the messenger wire consisting of a three-screw Detroit clamp, a ½-in. hanger rod and a malleable clip to grip the messenger wire, making a rigid hanger. However, for the extension, the hanger shown in Fig. 2 and designed by L. B. Cramer, electrical engineer of the company, is used and it has proved so satisfactory that it has been adopted as standard for all future work. The design consists of a ⅛ in. x 1 in. hanger strap formed into a loop at the messenger end so that it can be hooked over the messenger wire but can not unhook after the trolley clamp is installed. The loop is 3 in. long, permitting vertical movement of the trolley wire and thus eliminating hard spots, the trolley wire practically floating on the trolley wheel. The trolley clamp consists of two malleable castings held together by a ½-in. machine bolt which also passes through the end of the hanger strap. In tightening this bolt, the clamping jaws are

caused to grip the trolley wire. These clamping jaws are made very thin so that they cannot be struck by the passing trolley wheels. The complete hanger is very simple and light, yet strong and easily installed. On certain stretches of track, speeds of from 60 to 65 miles per hour are attained and there is no trouble with the wheels leaving the trolley wire nor is

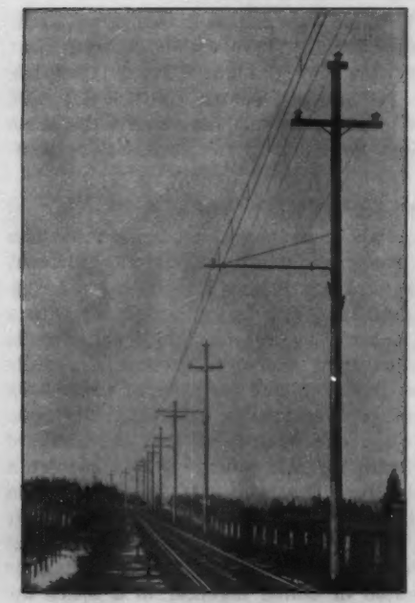


Fig. 1.

Fig. 2.

there any trouble from sparking, although the trolley voltage is 1300.

The pole spacing is 150 ft. on tangents except for city work and curves, where 120-ft. spans are used. The catenary hangers are spaced 25 ft. apart on tangents and somewhat closer on curves. Where the curves are severe, requiring pulloff wires to keep the trolley wire close to the center of the track, a special yoke is used at the messenger end of the hanger to which the bridle pulloff wire is attached. The lower wire of the bridle is fastened to an eye held by the bolt of the trolley clamp. With this arrangement, the trolley and messenger wires are pulled into position but the hanger is still free to travel vertically so that no hard spots are introduced into the trolley wire at pulloff points. The catenary material was furnished by the Ohio Brass Company.

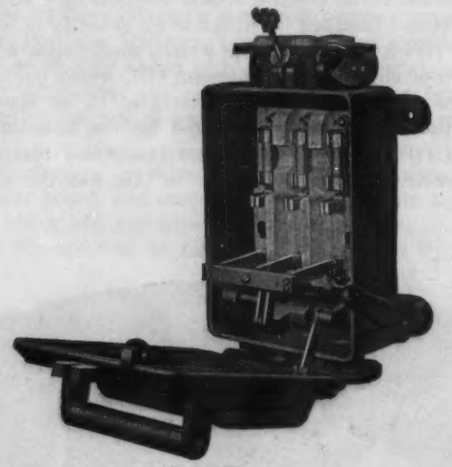
BOOK REVIEW.

Light. Photometry and Illumination. By William Edward Barrows, Jr., B.S., E.E. Size: 6½ in. x 8½ in.; 327 pages; 196 illustrations; cloth binding. Published by McGraw-Hill Book Company of New York and for sale at the Technical Book Shop, 106 Rialto Bldg., San Francisco. Price $3.00.

William E. Barrows, the author of this book, and who is professor of electrical engineering at the University of Maine, has in these pages completely rewritten a previous book entitled "Electrical Illuminating Engineering." The added features of this new publication consist of recent matter of utmost importance which has been gleaned from the transactions of the national engineering societies, articles appearing in the technical press and in addition the author's own revised views. The book is intended for use both in the college and in the field. The summarized, boiled down matter appearing at the end of each chapter relative to more extended discussion elsewhere in its pages will make the book especially useful to practising engineers as a ready reference or summary of important theory involved. The book treats of all phases of illumination and will be found useful to engineers and college students alike.

"D & W" FUSED SWITCH BOXES.

To meet the demand for an improved, combined switch and fuse box the "D & W" Fuse Company have brought out a new line of fused switch boxes for 250 volt d.c. circuits. These boxes are particularly adapted for mill service since they may be permanently locked after the fuses are installed, thereby preventing any tampering with the connections or increasing the capacity of the fuses. At the same time, they can be used as a switch since the circuit can be opened or closed at will by simply moving the lever at the side of the box. When the cover is opened the circuit is likewise opened, which makes it impossible to re-fuse the circuit when the switch is closed.



Improved Switch Boxes.

In designing these boxes they have introduced no complicated mechanism, but have used a very simple but substantial construction which will give indefinite service, since the operation of the switch is not dependent on springs.

These boxes are provided with rubber gaskets which render them positively waterproof provided that the terminal wires are taped in at the bushings or protected by outlet hoods when conduit connections are made. To facilitate installing these boxes removable porcelain bushings are used through which the cable terminals may be readily passed.

TELEPHONE TRAIN DISPATCHING ON THE PORTLAND RAILWAY, LIGHT & POWER CO. ELECTRIC LINE.

The Portland, Oregon, Railway, Light & Power Company has recently placed an order with the Western Electric Company for apparatus to be used in equipping its electric interurban railroad lines with telephone train-dispatching equipment of the latest and most efficient type. In fact, apparatus of another make, at present in use on one of the divisions, is to be dispensed with and the new apparatus installed in its place. One division to be equipped extends from Portland to Cazadero, Oregon, a distance of approximately forty miles, while the other is the Mt. Hood division, extending from Portland to Bull Run, a distance of approximately thirty miles. The dispatcher will be located at Portland. Seventeen way stations in all will be equipped with No. 102-A selector sets, containing the standard Western Electric No. 50 type selector. The circuits, however, are so arranged that an ultimate of thirty-six stations can be equipped with selector apparatus.

The Northwest Steel Company of Portland has been awarded a contract for the steel work on the power house of the Northwestern Electric Company on the White Salmon River, near Underwood, Wash. This power house and the storage dam of solid concrete, 125 feet high and 100 feet thick at the base, are being hurried to completion.

NEWS NOTES

INCORPORATIONS.

SAN FRANCISCO, CAL.—Wizard Electric Company, $25,000, shares $10 each, subscribed $50, by C. M. Claussen, W. A. McKay, W. F. Rose, M. Claussen and L. Krull.

ILLUMINATION.

POCATELLO, IDAHO.—The generating machinery of the Pintsch Gas Company was wrecked in a recent fire.

LATAH, WASH.—The town has voted to install electric lights and a water system. Bonds for $11,000 will be issued by the council.

ALAMEDA, CAL.—A resolution has been adopted ordering the clerk to advertise for bids for the installation of electroliers in that district lying east of Park st.

BEND, ORE.—Steidl & Tweet have been granted a franchise for an electric light and power system, water system and electric street railway system in Bond Park and the first and second additions to Bond Park.

SAN JOSE, CAL.—An alternative writ of prohibition has brought the State Railroad Commission into the Superior Court to show that the Commission has power to regulate the gas rates in Palo Alto and contiguous territory. The Palo Alto Council made a rate of $1.25 per 1000 cubic feet, and a temporary restraining order was obtained pending an action for a permanent order.

HOOD RIVER, ORE.—The Hood River Gas & Electric Company has begun work on its electric power plant here, which will be enlarged and have additional machinery installed. The company's dam on Hood river will practically be rebuilt and when completed will afford much additional power. A new 300 horsepower generator will be installed as well as several additional transformers.

SAN FRANCISCO, CAL.—The Railroad Commission has rendered a decision granting authority to the Central California Gas Company to issue additional bonds to the amount of $129,000 and additional preferred stock to the amount of $136,209. The company operates in Tulare County and will use the proceeds from the sale of the securities to purchase the Consolidated Heat, Light & Power Company of Visalia and Tulare, to construct a transmission line from Exeter to Visalia, to construct additions to the gas plant in Visalia and the distributing systems in Visalia and Tulare, to purchase and erect a gasholder in Porterville, to construct a transmission line from Porterville to Lindsay, to construct a transmission line from Lindsay to Exeter, to construct a distributing system in Lindsay, and to construct a distributing system in Exeter.

TRANSMISSION.

KLAMATH FALLS, ORE.—The California & Oregon Power Company has completed its power line from the south into Klamath Falls and connected with the power lines here.

SAN FRANCISCO, CAL.—The Railroad Commission has granted the application of the Mt. Whitney Power & Electric Company to put into effect a new form of meter contract for power, providing for a minimum of $24 a year.

PORTLAND, ORE.—It is announced that the Northwestern Electric Company, recently granted a franchise to enter the city, will erect a substation at a cost of $300,000, and its initial outlay for buildings, etc., will be $1,000,000.

TACOMA, WASH.—Failing in his attempt to dispose of his power site on the White River to the city of Seattle for $1,000,000, P. H. Hobb of this city has made application to the Tacoma City Council for a franchise to sell electric current to the city.

GRANTS PASS, ORE.—It is announced that the California-Oregon Light & Power Company has entered into sufficient contracts with the people of Fruitdale to insure the construction of the distributing line into that neighborhood. Many extensions will be made in that section.

LOS ANGELES, CAL.—President Williams of the City Council and Councilmen Whiffen and Betkouski are to be a special committee to negotiate with the power companies to learn if it would be possible for the city to acquire such portions of the power companies' systems as may be needed to distribute light and power from the aqueduct power plants.

SPOKANE, WASH.—The Washington Water Power Company, operating in the Spokane country, is building a high potential line from its distributing station at Wardner, Idaho, to Pine Creek, two miles southwest, from which point branch lines will be run to the Nabob mine, one mile, and to the Surprise properties, two miles. The line will run through the Bunker Hill & Sullivan ground.

PLACERVILLE, CAL.—The battle of property owners and residents of Placer and El Dorado Counties to forestall the Truckee River General Electric Company in its purpose to use the waters of Lake Tahoe to develop power has culminated in a suit to restrain the company from proceeding with its work. A complaint has been filed with the county clerk on behalf of the Western Company, a corporation, praying that a restraining order be issued against the Stone & Webster Construction Company and the Truckee River General Electric Company. The Western Company is a corporation heavily interested through ownership and mortgages in land fronting on Lake Tahoe. Wm. S. Tevis is president of the corporation.

TRANSPORTATION.

SAN FRANCISCO, CAL.—The State Railroad Commission has rendered a decision establishing through and joint rates between the Central California Traction Company and the Santa Fe.

LOS ANGELES, CAL.—Plans for new terminals for the San Pedro street line of the Pacific Electric on property back of the present depot, have been completed by Assistant Chief Engineer Johnson.

LA GRANDE, ORE.—Grand Ronde citizens are much pleased over the prospects for an electric line which is to girdle the valley. A survey extending from La Grande to Cove, thence to Imbler and back via Alicel Island City having just been completed.

ASTORIA, ORE.—Surveyors working for the United Railway Company of Portland, are running lines and getting levels for a proposed extension of the United Railway's track from Banks, in the north section of Washington county, through the Nehalem valley to this place.

SEATTLE, WASH.—Property owners living on the heights above Gatewood street in the southeastern part of the city are circulating a petition for a street railway line in Thirty-fifth avenue S. W. from Alaska street to the city limits, same to be presented to the Puget Sound Traction, Light & Power Company, and possibly to the city council.

OAKLAND, CAL.—The new Alameda-Oakland cross-town line of the Southern Pacific has been started. The

schedule was prepared and the cars tried out and inspected at the Alameda Point electric railroad shops last week. The cars are operated around the Alameda loop, thence across the marsh to Fourteenth and Franklin streets, Oakland, and on to the Sixteenth street depot.

SEATTLE, WASH.—Residents of the heights above Gatewood street, in the southwestern part of the city, are circulating petitions for a street railway line in Thirty-fifth avenue southwest, from Alaska street to the city limits. The petition will be presented to the officials of the Puget Sound Traction, Light & Power Company, and possibly to the city council.

RICHMOND, CAL.—Three street railway franchises were applied for at the last meeting of the city council. Two of the franchises were asked by the Southern Pacific. The third franchise was solicited by the San Francisco-Oakland Terminals Railway Company for permission to lay tracks in Ashland avenue. This was the franchise that was in dispute between the city and the traction company.

SANTA BARBARA, CAL.—R. H. Gaud and the Santa Barbara & Suburban Railway Company, have joined in a petition to the Railroad Commission asking that the former be allowed to transfer to the latter his street railway franchise in the city of Santa Barbara. The Santa Barbara and Suburban Railway Company also asks for a certificate of public convenience and necessity allowing it to operate under this franchise.

SAN FRANCISCO, CAL.—The Supervisors recently adopted by unanimous vote the resolution formulated by Supervisor Koshland and approved by the public utilities committee, specifying the terms upon which negotiations may be entered into with the United Railroads for the joint use of lower Market street, the first requirement being, as heretofore published, that the company cease at once all further efforts to establish its alleged rights in the courts.

VALLEJO, CAL.—Application was made recently to the Railroad Commission by the Vallejo & Northern Railroad for permission to issue $5,500,000 in bonds for the purpose of constructing an electric line between Sacramento and Vallejo, with ferry service to San Francisco. The Vallejo and Northern, while a separate corporation, will operate as an extension of the Northern Electric Railroad, connecting San Francisco with the rich territory of the Sacramento Valley.

SAN FRANCISCO, CAL.—The Board of Supervisors has directed the Board of Works to contract with the United Statet Steel Products Company for "track specials" and 110 tubular iron trolley poles for the Geary street municipal railway. The poles are to be used for the ocean beach extension of the line. For the "track specials," which include curve connections and the like, $8618 of municipal railway bond issue was ordered set aside, with $3500 for the trolley poles.

SUISUN, CAL.—The contractor for the grading of the Oakland, Antioch & Eastern Railway Company's electric railroad which it proposes to build through the eastern part of this county, has begun to assemble a large grading crew in a camp near Birds Landing, and the work will begin within a few days. The company has awarded the contract to the Union Gas Engine Company for the machinery in its new ferry boat, which will be about the size of one of the Key Route boats operating on San Francisco Bay.

TELEPHONE AND TELEGRAPH.

TEKOA, WASH.—A ten-year telephone franchise has been granted to Wm. Anderson.

SHELTON, WASH.—The Harstine Telephone Company has made application for a franchise in Mason County.

SPARKS, NEV.—The Sierra Telephone Company has asked for a franchise for a telephone system in this city.

RIALTO, CAL.—The Pacific Telephone & Telegraph Company will bid for a franchise to operate lines in this city.

EPHRATA, WASH.—The Grant Realty Company of Neppel, will extend its phone line to this place to connect with the Pacific States line.

NYSSA, ORE.—The Malheaur Home Telephone Company will do extensive reconstruction work on its lines in this town and vicinity

CONCRETE, WASH.—Stockholders of the Skagit River Telephone Company have decided to extend the telephone system to Marblemount.

RIVERSIDE, WASH.—J. H. Green, president of the Tunk Creek Telephone Company, announces that a line is to be constructed from Synarep to Anglin.

CONCRETE, WASH.—The Skagit River Telephone Company has decided to extend its line to Marblemount from Rockport, a distance of ten miles. Wm. Jennings is president of the company.

COURTLAND, ARIZ.—The various telephone subscribers of the local exchange have received notice that the local lines have been taken over by the New State Telephone & Telegraph Company, being a consolidation of the Courtland & Riggs Telephone Company and the Adams Telegraph Company.

WATERWORKS.

CHANDLER, CAL.—Dr A. J. Chandler has had plans prepared by Chief Engineer Binkley for a thoroughly up-to-date water system for the new town of Chandler. It will consist of 16-inch mains and 12, 10, 8, 6 and 4-inch laterals.

RICHMOND, CAL.—Arrangements have been completed with the People's Water Company of this city by the John Nicholl Company, whereby this company will take immediate steps in laying water mains in the new Richmond Terrace.

RIVERSIDE, CAL.—By an overwhelming vote the directors of the Riverside Water Company have decided to sell the company's domestic water plant to the city. A city election will be called at an early date to vote on issuing of $600,000 bonds for the purchase.

ELLENSBURG, WASH.—J. D. Matthews, manager of the Ellensburg Gas & Water Company, announces that he has completed arrangements for building a concrete sanitary filtering plant. Plans have also been completed for the 600,000 gallon reservoir now under construction.

PORTLAND, ORE.—Geo. Henry Jr., engineer, acting for the Pacific Power & Light Company, has placed a contract with the Mannesman Tube Works of Germany for 3600 tons of lap welt pipe, to stand working pressure of 2100 feet of water, to be tested in shop to 50 per cent above that.

SAN FRANCISCO, CAL.—A joint resolution fathered by the public utilities and water rates committees has been adopted by the Board of Supervisors, stating that it is the policy of the board to extend water service at the earliest possible date to all parts of the city now having an inadequate supply, and, if necessary, to take the money for such extensions out of the 1910 Hetch Hetchy bond issue fund. The public utilities and water rates commitees were instructed to meet at once with the city attorney, city engineer and officials of the Spring Valley Water Company to investigate the situation and to report back at the earliest possible date a plan for giving the needed relief and also to present drafts of all ordinances and resolutions necessary to carry their suggestions into effect.